OFFICE OF NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY

	FY 1995
Office of Nuclear Energy, Science and Technology - Grand Total	$48,165,000
Office of Engineering and Technology Development	$ 2,165,000
Space and National Security Programs	$ 2,165,000
Materials Preparation, Synthesis, Deposition, Growth or Forming	$ 1,435,000
Development of an Improved Process for the Manufacture of DOP-26 Iridium Alloy Blanks, Product Characterization and Exploratory Alloy Improvement Studies	965,000
Carbon-Bonded Carbon Fiber Insulation Production Maintenance, Manufacturing Process Development and Product Characterization	470,000
Materials Properties, Behavior, Characterization or Testing	$ 730,000
Development of an Improved Carbon-Carbon Composite Graphite Impact Shell Replacement Material	370,000
Development of Materials for Advanced Radioisotope Power Systems	360,000
Office of Naval Reactors	$46,000,000*

*This excludes $44 million for the cost of irradiation testing in the Advanced Test Reactor (ATR).

OFFICE OF NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY

OFFICE OF ENGINEERING AND TECHNOLOGY DEVELOPMENT

SPACE AND NATIONAL SECURITY PROGRAMS

Space and National Security Programs include the development and production of radioisotope power systems for both space and terrestrial applications and the technical direction, planning, demonstration and delivery of nuclear reactor power and propulsion systems for military and civilian space missions and for special military terrestrial applications. During FY1995, nuclear reactor power system activities were phased out. Essentially all materials programs were designed to support the production of General Purpose Heat Source-Radioisotope Thermoelectric Generators for the NASA Cassini Mission and preliminary scoping studies for support of the future Pluto Express NASA mission. This applied materials research programs are supported in the areas of thermoelectric materials and devices, advanced energy conversion systems, high temperature heat source materials, materials systems compatibility and safety related materials characterization and testing.

MATERIALS PREPARATION, SYNTHESIS, DEPOSITION, GROWTH OR FORMING

264. **DEVELOPMENT OF AN IMPROVED PROCESS FOR THE MANUFACTURE OF DOP-26 IRIDIUM ALLOY BLANKS, PRODUCT CHARACTERIZATION, AND EXPLORATORY ALLOY IMPROVEMENT STUDIES**
$965,000
DOE Contact: W. Barnett, (301) 903-3097
RNL Contacts: E. P. George, (615) 574-5085 and E. K. Ohriner, (615), 574-8519

An iridium alloy, DOP-26 (i.e., Ir-0.3 wt.% W with Th and Al dopant additions), serves as the fuel clad or capsule material for isotope heat sources employed in recent and contemporary space power systems for NASA deep space missions. This program is aimed at the optimization of the new improved process route previously selected for the production of DOP-26 iridium alloy sheet, namely a consumable vacuum arc cast/extrusion/"warm" rolling route. The effectiveness of this production process was further demonstrated in the FY 1995 production of DOP-26 alloy blanks, foil and clad vent sets for the Cassini Mission. Production yields have continued to exceed our goals.

Significant progress was made in the preparation for introducing bare rolling into the sheet production process. Crowned carbide rolls are being procured to evaluate possible improvements in sheet shape control. A suitable die/lubrication system for bare forming of clad vent set cups was identified.

Studies of bare rolling of blank stock and bare forming of cups was continued.

Continued product characterization studies, particularly for simulated service conditions, continued to show behaviors equivalent or superior to the prior process product.

Studies of alternate iridium alloy doping agents were continued. The objective is to maintain or exceed the properties of the DOP-26 alloy at a significantly lower thorium dopant level. An iridium alloy containing 0.3 wt.%W with dopant additions of 40 appm cerium and 15 appm thorium was selected for scale-up. A nominal six kilogram consumable arc melted ingot was preferred, extruded and sheet preparation was initiated.

Keywords: Consumable Arc Melt, Extrusion, Noble Metal

265. **CARBON-BONDED CARBON FIBER INSULATION PRODUCTION MAINTENANCE, MANUFACTURING PROCESS DEVELOPMENT AND PRODUCT CHARACTERIZATION**
$470,000
DOE Contact: W. Barnett, (301) 903-3097
ORNL Contacts: C. E. Weaver and R. Dunwiddie, (615) 574-9978

Carbon-bonded carbon fiber (CBCF) type thermal insulation material is employed in Isotopic General Purpose Heat Source (GPHS) Module assemblies for use in current GPHS-RTG (radioisotope thermoelectric generator). This material was originally employed in GPHS-R7Gs for the Galileo/NASA (1989 launch) and Ulysses/NASA-ESA (1990 launch) Missions. Material produced for the Cassini Mission (1997 launch) was made with a replacement carbon fiber (new vendor, former source not available) utilizing an optimized process and process controls. The FY 1995 program encompassed (1) maintenance of capability for both tube and plate billet production through the year, and (2) characterization of Cassini CBCF insulation thermal conductivity.

Particular attention was focused on evaluation of the effects of short-term very high temperature short-time exposures on thermal conductivity. Equations were developed which express thermal conductivity as a function of temperature and peak exposure temperature and time.

Keywords: Insulators/Thermal, High Temperature Service, Fibers

MATERIALS PROPERTIES, BEHAVIOR, CHARACTERIZATION OR TESTING

266. **DEVELOPMENT OF AN IMPROVED CARBON-CARBON COMPOSITE GRAPHITE IMPACT SHELL REPLACEMENT MATERIAL**
$370,000
DOE Contact: W. Barnett, (301) 903-3097
Oak Ridge National Laboratory Contact:
G. R. Romanowski, (616) 574-4838

The Graphite Impact Shell (GIS), a component of the General Purpose Heat Source isotopic heat source module is a closed end/capped tubular shape machined from AVCO 3D-CC fine weave pierced fabric material. It is anticipated that a change in the fiber reinforcement architecture from the current orthogonal structure to a cylindrical type structure will enhance energy absorption in high velocity impact. The current program is a feasibility study of commercially available and experimental materials.

During FY 1995 impact tests were conducted on all 38 candidate materials representing at least two levels of densification for each architectural variant. Impact testing was performed at 55 m/s using a copper mass simulant to match the typical mass of a GPHS fueled clad. Force versus time was measured at the impact face. While significant improvement in hoop strength was attained, only minor enhancement in energy absorption was achieved.

Keywords: Composites, Carbon-Carbon

267. **DEVELOPMENT OF MATERIALS FOR ADVANCED RADIOISOTOPE POWER SYSTEMS**
$360,000
DOE Contact: W. Barnett, (301) 903-3097
Iowa State University, Ames Laboratory Contact:
B. Cook, (515) 294-9673

The objectives of this activity are: (1) evaluate the potential of new thermoelectric materials, (2) develop and characterize rare earth based selective emitters for potential thermophotovoltaic systems application, provide support in the areas of materials compatibility and transport.

Keywords: Radioisotope Power, Thermoelectrics, Thermophotovoltaics

OFFICE OF NAVAL REACTORS

The materials program supports the development and operation of improved and longer life reactors and pressurized water reactor plants for naval nuclear propulsion.

The objective of the materials program is to develop and apply, in operating service, materials capable of use under the high power density and long life conditions required of naval ship propulsion systems. This work includes irradiation testing of reactor fuel, poison, and cladding materials in the Advanced Test Reactor at the Idaho National Engineering Laboratory. This testing and associated examination and design analysis demonstrates the performance characteristics of existing materials as well as defining the operating limits for new materials.

Corrosion, mechanical property, and wear testing is also conducted on reactor plant structural materials under both primary reactor and secondary steam plant conditions to confirm the acceptability of these materials for the ship life. This testing is conducted primarily at two Government laboratories-Bettis Atomic Power Laboratory in Pittsburgh and Knolls Atomic Power Laboratory in Schenectady, New York.

One result of the work on reactor plant structural material is the issuance of specifications defining the processing and final product requirements for materials used in naval propulsion plants. These specifications also cover the areas of welding and nondestructive testing.

Funding for this materials program is incorporated in naval projects jointly funded by the Department of Defense and the Department of Energy. This funding amounts to approximately $90 million in FY1995 including approximately $44 million as the cost for irradiation testing in the Advanced Test Reactor. The Naval Reactors contact is David I. Curtis, (703) 603-5565.